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(54) BALLOON CATHETER WITH RADIOPAQUE MARKING

BALLONKATHETER MIT RADIOPAKER MARKIERUNG

CATHÉTER À BALLONNET AVEC MARQUAGE RADIO-OPAQUE

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US-A1- 2011 009 818 US-B1- 6 306 144

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Description

Technical Field

[0001] This disclosure relates generally to interventional medical procedures, such as angioplasty, and, more particularly, to a balloon catheter with a transient radiopaque marking.

Background of the Invention

[0002] Catheters including balloons are routinely used to resolve or address flow restrictions or perhaps even complete blockages in tubular areas of a body, such as arteries or veins. In many clinical situations, the restrictions are caused by hard solids, such as calcified plaque, and may sometimes involve the use of high pressures to compact such blockages. Commercially available balloons employ complex technology to achieve high pressure requirements without sacrificing the profile of the balloon. Besides high pressure requirements, the balloons should also be resistant to puncture, easy to track and push, and present a low profile, especially when used for angioplasty.

[0003] The clinician performing the angioplasty procedure should be able to locate the position of the uninflated balloon with accuracy, so that the balloon will be properly positioned once inflated. This is conventionally accomplished by attaching marker bands on the catheter shaft corresponding to the ends of the balloon working surface. This "working surface" is the surface along the portion of the balloon that is used to achieve the desired treatment effect, such as contacting the calcified plaque (which surface in the case of a balloon having conical or tapering sections at the proximal and distal ends is typically co-extensive with a generally cylindrical barrel section).

[0004] However, misalignment of the marker bands during placement along the shaft sometimes results in their failure to correspond precisely to the extent of the working surface. This misalignment may prevent the clinician from accurately identifying the location of the working surface of the balloon during an interventional procedure. Also, when successive intravascular interventions are made, such as during a pre-dilatation using a first catheter followed by dilatation using a second catheter, the clinician must guess at the location where the pre-dilatation occurred. In any case, this uncertainty may lead to a geographic misalignment, or "miss," of the intended contact between the intended treatment area and the working surface of the balloon. It is especially desirable to avoid such an outcome when the balloon is designed to deliver a payload (such as a therapeutic agent (e.g., a drug, such as paclitaxel, rapamycin, heparin and the like), a stent, a stent graft, or a combination) or a working element (such as a cutter, focused force wire, or the like) to a specified location within the vasculature, since a miss may, at a minimum, prolong the procedure (such as, for example, by requiring redeployment of the balloon or the

use of another balloon catheter in the case of a drug coated balloon), and possibly result in an inferior outcome if the lesion is not properly treated as a result of the misalignment.

5 [0005] US 2011/009818 A1 discloses a device for the transfer of radiopaque material within the body comprising a valvuloplasty or other balloon coated with the radiopaque material.

10 [0006] US 2006/036316 A1 relates to polymeric medical devices, such as stents.

[0007] US 5893840 A discloses balloon catheters which are prepared to include body affecting chemicals within microcapsules on the exterior of the balloon either alone or with a stent.

15 [0008] US 6306144 B1 relates to a predetermined arrangement of differentially lubricious areas on a balloon catheter for controlling against unexpected movement of a stent carried thereon when in situ in the body.

[0009] In order to assess the length of a lesion from a location external to the body, a clinician may use an external ruler, which in one form is called a "LeMaitre" tape. While the use of such a ruler or tape may allow for a more precise assessment of the lesion length and an area treated by a predilatation step, it is not without limitations.

20 For one, a displacement or difference in the apparent position of the lesion margins results when viewed along two different lines of sight. This "parallax" can lead to an inaccurate measurement and, at a minimum, contribute to the geographic misalignment of the working surface relative to the lesion. The use of such a ruler may also lead to inferior measurements when the vasculature at issue is particularly tortuous.

25 [0010] Accordingly, a need exists for a manner in which to position a balloon catheter into the vasculature at a treatment area with enhanced accuracy.

Summary of the Invention

40 [0011] The present invention is recited in claim 1. Preferred embodiments are recited in the dependent claims thereof. An object of the disclosure is to provide a catheter balloon with a transient radiopaque marking for use in marking a treatment area in the vasculature, which marking may then be used to ensure the accurate application of a treatment to the treatment area.

45 [0012] In one aspect, a kit for treating a treatment area in the vasculature is provided. The kit comprises a first catheter adapted for positioning at the treatment area, said first catheter including a first balloon having a transient radiopaque material corresponding to the treatment area, and a second catheter adapted for positioning at the treatment area. The second catheter may include a treatment that substantially matches the transient radiopaque material, preferably so that the length and/or position of the treatment corresponds to the length and/or position of the transient radiopaque material.

55 [0013] The second catheter may include one or more radiopaque markings for identifying the location of the

treatment. A length of the transient radiopaque material may be substantially identical to a length of the treatment. The second catheter may include a second balloon having a working surface including the treatment. A position of the transient radiopaque material may correspond to

an end of the working surface of the second balloon.
[0014] In any embodiment, the treatment may be selected from the group consisting of a drug, a stent, a stent graft, a cutter, a focused force wire, or any combination thereof. In any case, a length of the treatment may substantially match the length of the transient radiopaque marking. The transient radiopaque marking may be a material selected from the group consisting of a radiopaque dye, powder, or gel. A bioresorbable stent may include the transient radiopaque marking, or the transient radiopaque marking may comprise a layer of the first balloon.

[0015] Another aspect of the disclosure pertains to a kit for treating a treatment area in the vasculature. The kit comprises a first catheter adapted for positioning at the treatment area in the vasculature. The first catheter includes a first balloon having a transient radiopaque material having first and second ends corresponding to the treatment area. A second catheter adapted for positioning at the treatment area includes a treatment having first and second ends corresponding to the first and second ends of the transient radiopaque material.

[0016] The second catheter may include one or more radiopaque markings for identifying the location of the treatment. A length of the transient radiopaque material may be substantially identical to a length of a first working surface of the first balloon. The treatment may be selected from the group consisting of a drug, a stent, a stent graft, a cutter, a focused force wire, or any combination thereof. A length of the treatment may substantially match the length of the transient radiopaque marking. The transient radiopaque marking may comprise a strip, band, or pattern of a radiopaque material.

[0017] The second catheter may include a second balloon having a working surface including the treatment. The transient radiopaque marking may be coated over at least a portion of the first balloon, disposed in a porous structure of the first balloon, disposed in wells on the first balloon, provided as a plurality of microdots on the first balloon, present on the first balloon under a membrane, or any combination thereof. The transient radiopaque marking may be permanent.

[0018] A further aspect of the disclosure relates to a method of performing an intervascular procedure at a treatment area. The method comprises the steps of transferring a transient radiopaque material corresponding to the treatment area from a first balloon to the treatment area, and providing a treatment to the treatment area, the treatment corresponding in length to the transient radiopaque material.

[0019] The treatment area may be a lesion having a length, and including the step of providing the treatment corresponding to the length of the lesion. The method may also comprise providing the transient radiopaque

marking corresponding to the length of the lesion. The method may further include the step of providing the transient radiopaque marking bounding a working surface of the first balloon. The step of providing the treatment may include providing a therapeutic agent, a stent, a stent graft, a cutter, a focused force wire, or any combination thereof. The step of providing the treatment may also comprise providing a second balloon on the catheter.

[0020] A further aspect of the disclosure relates to a kit for treating a treatment area in the vasculature. The kit comprises a first catheter adapted for positioning at the treatment area, said first catheter including a first balloon having a transient radiopaque material corresponding to the treatment area, and a second catheter adapted for positioning at the treatment area, said second catheter including a therapeutic agent that substantially corresponds to the transient radiopaque material, preferably so that the length and/or position of the therapeutic agent corresponds to the length and/or position of the transient radiopaque material. The therapeutic agent may be selected from the group consisting of paclitaxel, rapamycin, heparin, or any combination thereof, and the second catheter may include a balloon carrying the therapeutic agent.

[0021] Still a further aspect of the disclosure relates to a kit for treating a treatment area in the vasculature. The kit comprises a first catheter adapted for positioning at the treatment area in the vasculature, said first catheter including a first balloon having a first, transient radiopaque material corresponding to the treatment area, and a second catheter adapted for positioning at the treatment area. The second catheter includes a second balloon having a working surface identified by a second radiopaque marking. The second radiopaque marking may include at least two bands formed of a radiopaque material connected to a tube of the second catheter.

[0022] A further aspect of the disclosure pertains to an assembly for treating a treatment area in the vasculature, comprising: a first catheter adapted for positioning at the treatment area in the vasculature, said first catheter including a first balloon having a transient radiopaque material corresponding to the treatment area; and a second catheter adapted for positioning at the treatment area, said second catheter including a treatment that substantially corresponds to the transient radiopaque material, preferably so that the length and/or position of the treatment corresponds to the length and/or position of the transient radiopaque material. The second catheter may include a second balloon having a working surface when inflated, the working surface including the treatment.

Brief Description of the Figures

[0023]

Figures 1 to 4 show a catheter used in embodiments of the present disclosure.

Figures 5A to 5G show details of a first catheter used

in embodiments of the present disclosure.

Figures 6A to 6C show details of surface treatments used in catheters used in embodiments of the present disclosure.

Figures 7A to 9B show details of further surface treatments used in catheters used in embodiments of the present disclosure.

Figures 10 to 12 show a way in which a catheter kit according to embodiments of the present disclosure is used.

Modes for Carrying Out the Invention

[0024] The description provided below and in regard to the figures applies to all embodiments unless noted otherwise, and features common to each embodiment are similarly shown and numbered.

[0025] Provided is a catheter 10 having a distal portion 11 with a balloon 12 mounted on a catheter tube 14. Referring to Figures 1, 2, and 3, the balloon 12 has an intermediate section 16, or "barrel" having a working surface W, and end sections 18, 20. In one embodiment, the end sections 18, 20, taper or reduce in diameter to join the intermediate section 16 to the catheter tube 14 (and thus sections 18, 20 are generally termed cones or cone sections). The balloon 12 is sealed to catheter tube 14 at balloon ends (proximal 15a and distal 15b) on the end sections 18, 20 to allow the inflation of the balloon 12 via one or more inflation lumens 17 extending within catheter tube 14 and communicating with the interior of the balloon 12.

[0026] The catheter tube 14 also includes an elongated, tubular shaft 24 forming a guidewire lumen 23 that directs the guidewire 26 through the catheter 10. As illustrated in Figure 3, this guidewire 26 may be inserted through a first port 25 of a connector 27 into the lumen 23 to achieve an "over the wire" (OTW) arrangement, but could also be provided in a "rapid exchange" configuration in which the guidewire 26 enters the lumen 23 through a lateral opening 14a closer to the distal end (see Figure 4). A second port 29 may also be associated with catheter 10, such as by way of connector 27, for introducing a fluid (e.g., saline, a contrast agent, or both) into the interior of the balloon 12 via the inflation lumen 17.

[0027] Balloon 12 may include a single or multi-layered balloon wall 28. The balloon 12 may be a non-compliant balloon having a balloon wall 28 that maintains its size and shape in one or more directions when the balloon is inflated. The balloon 12 in such case also has a pre-determined surface area that remains constant during and after inflation, also has a pre-determined length and pre-determined circumference that each, or together, remain constant during and after inflation. However, the balloon 12 could be semi-compliant or compliant instead, depending on the particular use.

[0028] The balloon 12 may be provided with a radiopaque material adapted for contacting a treatment area in order to at least partially transfer the material thereto

and form a radiopaque marking M that can be perceived under fluoroscopy (see Figures 10-12 and the corresponding discussion below). This temporary marking M may be achieved by providing a transient radiopaque material on the outer surface of the balloon 12 and, in particular, along the barrel section 16 between its ends. The skilled person will understand from that sentence that a "transient" material is a material producing a marking which may or may not be permanent.

[0029] As shown in Figures 5A-5G, this marking M may be provided in various shapes or sizes, including for example as one or more longitudinal strips (Figure 5A), full coverage of the barrel section 16 corresponding to the working surface W (Figure 5B), a pattern (Figure 5C), one or more circumferential bands (Figure 5D), or hash lines that may provide a ruler function (Figure 5E), or any combination of the foregoing. Combinations of markings M1, M2, can be used as shown in Figure 5F, in order to more clearly differentiate among different locations or parts of the working surface W of the balloon 12 (e.g., the terminal ends of the barrel section 16, which as will be understood upon reviewing the description that follows may correspond identically to a balloon subsequently used for treating the treatment area). Also, as shown in Figure 5G, the marking M may comprise a bioresorbable stent 39 that is transferred to the treatment area in order to provide the desired radiopaque quality prior to the treatment (see, e.g., U.S. Patent No. 7,951,194).

[0030] The radiopaque material may be sequestered or otherwise immobilized on the external surface of the balloon 12 in a variety of ways. For example, the radiopaque material may be a conventional radiopaque dye, which may be coated over a portion of the surface of the balloon 12, either with or without a suitable carrier compound. The radiopaque materials may also be used in the form of gels, powders, dust, particles, nano-particles, liquids, stains, adhesives and the like. The material could be anywhere from about 5-95% radiopaque or, more specifically, in the range of about 70-90% radiopacity. The radiopaque material could be one of many currently in use in medicine, including but in no way limited to: iodine, iopromide, metallic ions, gold, barium sulfate, or other similarly functional materials. In one embodiment, a bio-compatible adhesive could be mixed with the radiopaque material to promote adherence to the target area. The persistence of the dye or other radiopaque material could be temporary in nature, designed to last long enough to aid the procedure, or could be permanent.

[0031] At least a portion of the surface of the balloon 12 could be treated with folds or mini-folds designed to harbor the radiopaque material forming the transient marking M during delivery to the treatment area. Alternatively, the surface of the balloon 12 could be treated to have a surface geometry designed to hold the radiopaque material substantially in place until deployment at the target site. This surface treatment could include wells or micro-wells filled with the radiopaque material. The surface treatment could also include fine, hair-like struc-

tures coated with radiopaque material and designed to optimize surface contact and transfer. Further, these fine, hair-like structures could be made of radiopaque material and designed to separate from the balloon 12 and attach to the target tissue. The balloon surface could have raised micro-dots of radiopaque element in a gel form. These micro-dots of radiopaque gel could include adhesive properties to help attach to the contact surfaces within the body.

[0032] Alternatively, the balloon 12 could be constructed from several layers of material, with the inner layers providing the desired expansion properties. The outermost layer of the balloon 12 could be made of an absorbent material preloaded with radiopaque material so as to provide the transient marking M. This material could have sponge-like characteristics, which may contain pores filled with radiopaque dye. These pores could enclose the radiopaque gel of the uninflated balloon 12. Upon inflation, the pores may compress and force the radiopaque material onto the treatment area.

[0033] Figures 6A-6C show three specific examples of potential surface treatments applied to balloon 12 to enhance the delivery and transfer of the radiopaque material. As shown in Figure 6A, indented wells 30 can be formed over the central section 16 of the balloon surface to contain the radiopaque material. As shown in Figure 6B, raised dots 32 could consist of a gel mixed with the radiopaque material. Such dots or microdots can be formed into adherent admixtures applied as droplets and fixed to the surface of the balloon 12 upon drying or curing. As shown in Figure 6C, the radiopaque material can be maintained on the external surface of the balloon using a membrane 34. The radiopaque material may comprise microdots 32 or other layers or sources of the radiopaque material

[0034] Figures 7A and 7B illustrate that the external balloon surface, or another layer of material applied over the balloon surface, can be formed with sponge-like pores 40 which hold the radiopaque material 42. When the balloon is unexpanded, as shown in Figure 7A, the radiopaque material 42 is held tightly within the pores. When the balloon is expanded, as shown in Figure 7B, however, the pores stretch and expose the radiopaque material facilitating its release.

[0035] As shown in Figures 8A and 8B, the radiopaque material 50 may be layered over the balloon 12 with an outer, perforated layer 52 holding the radiopaque material in place, as shown in Figure 10. Upon balloon expansion, as shown in Figure 8A, the balloon 12 expands and forces the radiopaque material 50 out through the perforations 54 in the outer layer 52, releasing the radiopaque dye as shown in Figure 8B.

[0036] Figures 9A and 9B show a balloon 12 folded for delivery. The balloon 12 could be folded during manufacturing. The radiopaque material 62 is sequestered between folds or "lobes" 60 of the balloon 12. This configuration allows the radiopaque material 62 to be delivered to the treatment area site without being lost through con-

tact with other surfaces. The material 62 is then released upon balloon inflation.

[0037] The radiopaque material forming the transient marking M could be suspended in an aqueous solution applied to the surface during manufacturing and allowed to dry, evaporating off the water and leaving the radiopaque dye in place. Likewise, a solution based on acetone or isopropyl alcohol may speed the evaporation process. Radiopaque paint, varnish, resin, lacquer, polymer could be applied to the balloon 12. The radiopaque material could also be applied using vapor deposition, static deposition, or during a controlled coating, spraying, dipping, molding, or heating process. Alternatively, the radiopaque element could be combined with an ultraviolet sensitive substrate, applied to the device, and cured into place using UV curing processes.

[0038] In another approach, sheets of radiopaque material could be fabricated in a separate process, and the sheets then attached to the balloon 12 using adhesive, radio-frequency welding, thermal bonding or similar techniques. In still another approach, the radiopaque material could be combined with a substance which specifically or preferentially binds to tissue in the treatment area. Alternatively, radiopaque dye can be suspended in a biocompatible hydrogel and freeze-dried to form a solid that can be attached to the balloon 12. Upon sufficient combination with the fluids and heat of the body, the solid would liquefy, releasing the radiopaque material onto the target area. Additionally, the radiopaque element could be a powder, dust, or flakes applied to the surface of the balloon 12.

[0039] Figures 10-12 illustrate uses of a balloon 12 with a transient radiopaque marking M. Figure 10 shows a folded balloon 12 of catheter 10 including marking M being inserted along a guidewire G into a vessel V to a treatment area A, such as a lesion L, using a device called an introducer I. The marking M is provided on the balloon 12 such that it corresponds to the treatment area A (such as by defining at least the ends, and thus also substantially matches the ends or length of the working surface on a second balloon, which as noted below may provide dilatation and be provided during the same or a subsequent intervention). Upon this first balloon 12 being at least partially inflated, as shown in Figure 11, the transient radiopaque marking M is thus transferred to the treatment area A, but in a manner that is temporary rather than permanent. The balloon 12 may then be deflated, wrapped or folded, and withdrawn.

[0040] As shown in Figure 12, a treatment catheter 100 (which may be substantially identical in construction to catheter 10) may then be inserted to position a treatment balloon 112 at the treatment area A. This second balloon 112 may include a working surface W2 including a treatment, such as for example a therapeutic agent (e.g., a drug, such as paclitaxel, rapamycin, heparin and the like), a stent, a stent graft, or a combination) that corresponds to the treatment area A, such as in size (e.g., length). Using fluoroscopy, the clinician may match markings on

this catheter 100 (such as permanent bands 102 made of a radiopaque material and substantially matching the ends of the working surface W2 when the corresponding balloon 112 is inflated) with the now-transferred marking M in the vessel V corresponding to the treatment area A. When the balloon 112 is subsequently inflated to provide the treatment to the treatment area A (which may also involve fully compacting the lesion L), the clinician is assured that the delivery is achieved in the intended manner to the entire treatment area A, but not elsewhere, which may aid in avoiding geographic misalignment. Consequently, the procedure is potentially shortened, and a further intervention may be avoided.

Claims

1. A kit for treating a treatment area in a vasculature, comprising:
 - a first catheter (10) adapted for positioning at the treatment area (A), said first catheter (10) including a first balloon (12) having a radiopaque material corresponding to the treatment area (A); and
 - a second catheter (100) adapted for positioning at the treatment area (A), said second catheter (100) having a treatment that matches the radiopaque material.
2. The kit of claim 1, wherein the length and/or position of the treatment corresponds to the length and/or position of the radiopaque material.
3. The kit of claim 1 or 2, wherein the second catheter (100) includes one or more radiopaque markings (102) for identifying the location of the treatment.
4. The kit of claim 1 or 2, wherein a length of the radiopaque material is identical to a length of the treatment.
5. The kit of claim 1 or 2, wherein the second catheter (100) includes a second balloon (112) having a working surface including the treatment.
6. The kit of claim 5, wherein a position of the radiopaque material corresponds to an end of the working surface of the second balloon (112).
7. The kit of any of claims 1-6, wherein the treatment is selected from the group consisting of a drug, a stent, a stent graft, a cutter, a focused force wire, or any combination thereof.
8. The kit of claim 7, wherein a length of the treatment matches the length of the radiopaque marking.

9. The kit of claim 1 or 2, wherein the radiopaque marking is provided by a material selected from the group consisting of a radiopaque dye, powder, or gel.
10. The kit of claim 1 or 2, further including a bioresorbable stent including the radiopaque marking.
11. The kit of claim 1 or 2, wherein the radiopaque marking comprises a layer of the first balloon (12).

Patentansprüche

1. Satz zur Behandlung eines Behandlungsbereichs in einem Gefäßsystem, umfassend:
 - einen ersten Katheter (10), der zur Positionierung im Behandlungsbereich (A) angepasst ist, wobei der erste Katheter (10) einen ersten Ballon (12) einschließt, der ein röntgendichtes Material aufweist, das dem Behandlungsbereich (A) entspricht; und
 - einen zweiten Katheter (100), der zur Positionierung im Behandlungsbereich (A) angepasst ist, wobei der zweite Katheter (100) eine Behandlung einschließt, die dem röntgendichten Material entspricht.
2. Satz nach Anspruch 1, wobei die Länge und/oder Position der Behandlung mit der Länge und/oder Position des röntgendichten Materials übereinstimmt.
3. Satz nach Anspruch 1 oder 2, wobei der zweite Katheter (100) eine oder mehrere röntgendichte Markierungen (102) zum Identifizieren der Behandlungsstelle aufweist.
4. Satz nach Anspruch 1 oder 2, wobei eine Länge des röntgendichten Materials identisch mit einer Länge der Behandlung ist.
5. Satz nach Anspruch 1 oder 2, wobei der zweite Katheter (100) einen zweiten Ballon (112) einschließt, der eine Arbeitsfläche aufweist, welche die Behandlung einschließt.
6. Satz nach Anspruch 5, wobei eine Position des röntgendichten Materials mit einem Ende der Arbeitsfläche des zweiten Ballons (112) übereinstimmt.
7. Satz nach einem der Ansprüche 1-6, wobei die Behandlung aus der Gruppe ausgewählt ist, bestehend aus einem Arzneimittel, einem Stent, einem Stentgraft, einem Schneidwerkzeug, einem Focused-Force-Draht oder einer Kombination davon.
8. Satz nach Anspruch 7, wobei eine Länge der Behandlung mit der Länge der röntgendichten Markie-

rung übereinstimmt.

9. Satz nach Anspruch 1 oder 2, wobei die röntgendichte Markierung durch ein Material bereitgestellt ist, ausgewählt aus der Gruppe, bestehend aus einem röntgendichtem Farbstoff, Pulver oder Gel. 5
10. Satz nach Anspruch 1 oder 2, weiter einen bioresorbierenden Stent einschließend, der die röntgendichte Markierung einschließt. 10
11. Satz nach Anspruch 1 oder 2, wobei die röntgendichte Markierung eine Schicht des ersten Ballons (12) umfasst.

Revendications

1. Trousse pour traiter une région de traitement dans un système vasculaire, comprenant :

un premier cathéter (10) adapté pour être positionné au niveau de la région de traitement (A), ledit premier cathéter (10) incluant un premier ballonnet (12) présentant un matériau radio-opaque correspondant à la région de traitement (A) ; et 25

un second cathéter (100) adapté pour être positionné au niveau de la région de traitement (A), ledit second cathéter (100) présentant un traitement qui correspond au matériau radio-opaque. 30

2. Trousse selon la revendication 1, dans laquelle la longueur et/ou la position du traitement correspond à la longueur et/ou la position du matériau radio-opaque. 35
3. Trousse selon la revendication 1 ou 2, dans laquelle le second cathéter (100) inclut un ou plusieurs marqueurs radio-opaques (102) pour identifier l'emplacement du traitement. 40
4. Trousse selon la revendication 1 ou 2, dans laquelle la longueur du matériau radio-opaque est identique à une longueur du traitement. 45
5. Trousse selon la revendication 1 ou 2, dans laquelle le second cathéter (100) inclut un second ballonnet (112) présentant une surface de travail incluant le traitement. 50
6. Trousse selon la revendication 5, dans laquelle une position du matériau radio-opaque correspond à une extrémité de la surface de travail du second ballonnet (112). 55
7. Trousse selon l'une quelconque des revendications 1 à 6, dans laquelle le traitement est choisi dans le

groupe constitué d'un médicament, d'une endoprothèse, d'une endoprothèse couverte, d'une lame, d'un fil de force concentrée ou d'une quelconque combinaison de ces éléments.

8. Trousse selon la revendication 7, dans laquelle une longueur du traitement correspond à la longueur du marqueur radio-opaque.
9. Trousse selon la revendication 1 ou 2, dans laquelle le marqueur radio-opaque est fourni par un matériau choisi dans le groupe constitué d'un colorant, d'une poudre ou d'un gel radio-opaque.
10. Trousse selon la revendication 1 ou 2, incluant en outre une endoprothèse bio-résorbable incluant le marqueur radio-opaque.
11. Trousse selon la revendication 1 ou 2, dans laquelle le marqueur radio-opaque comprend une couche du premier ballonnet (12).

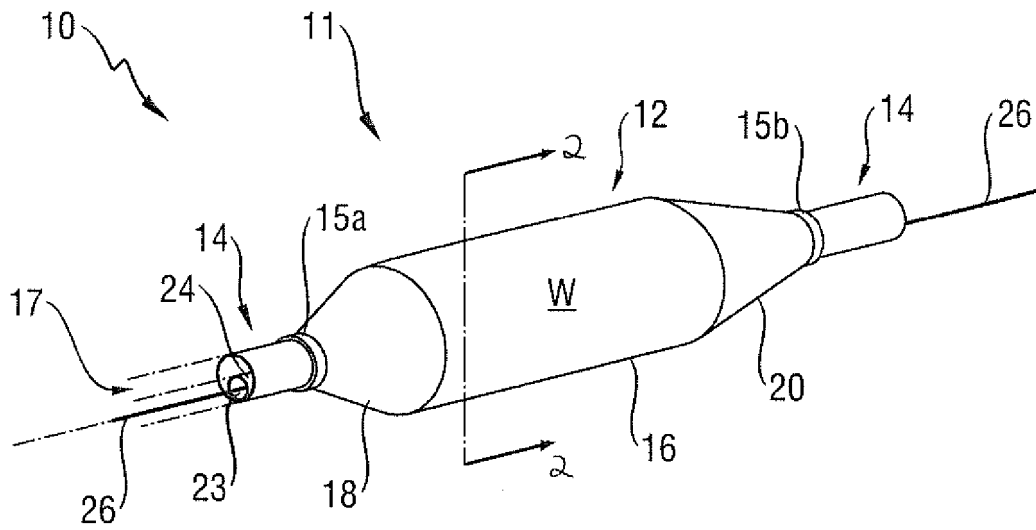


FIG. 1

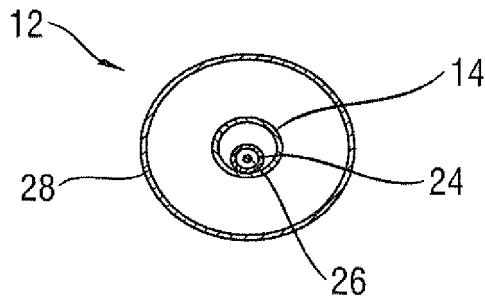


FIG. 2

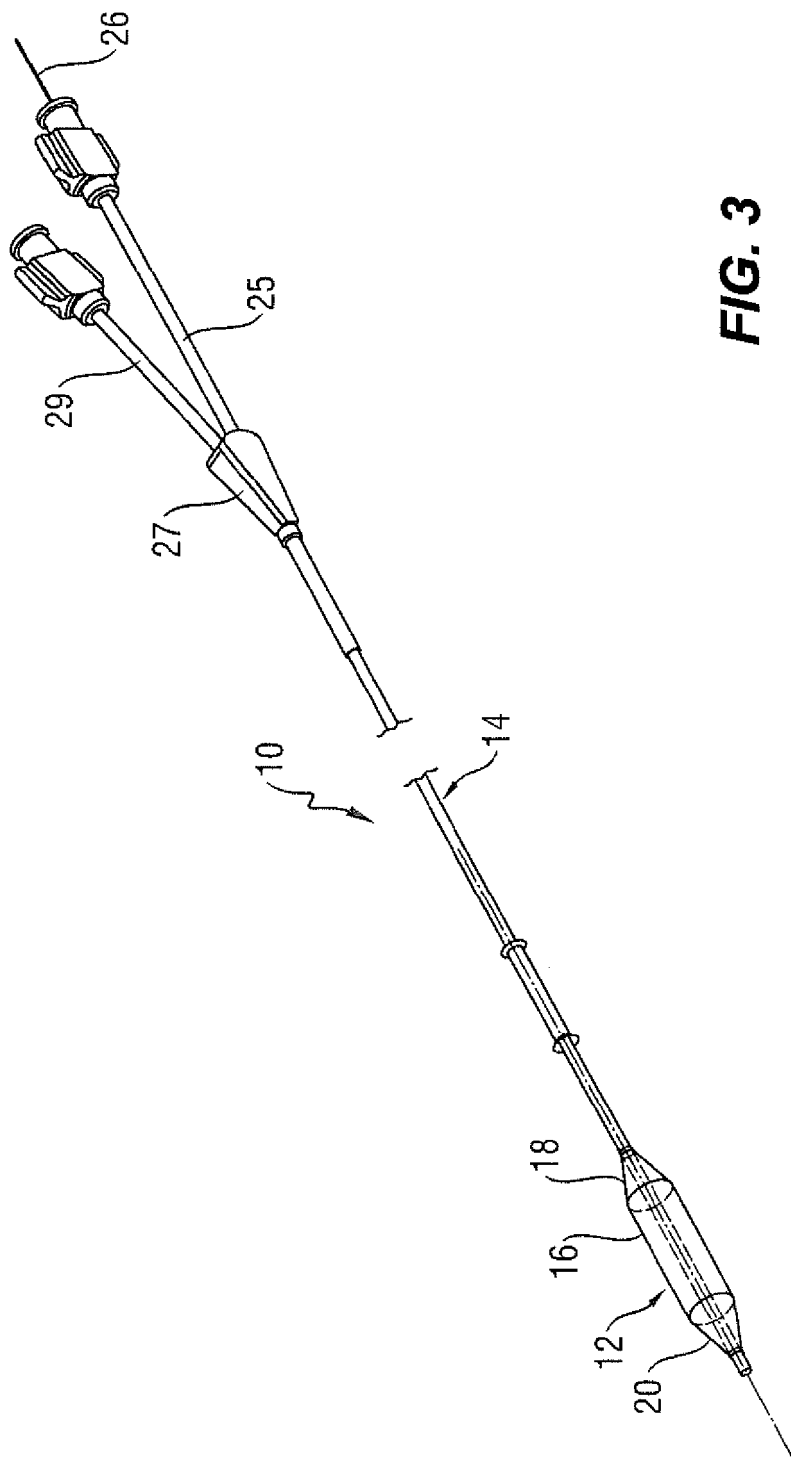


FIG. 3

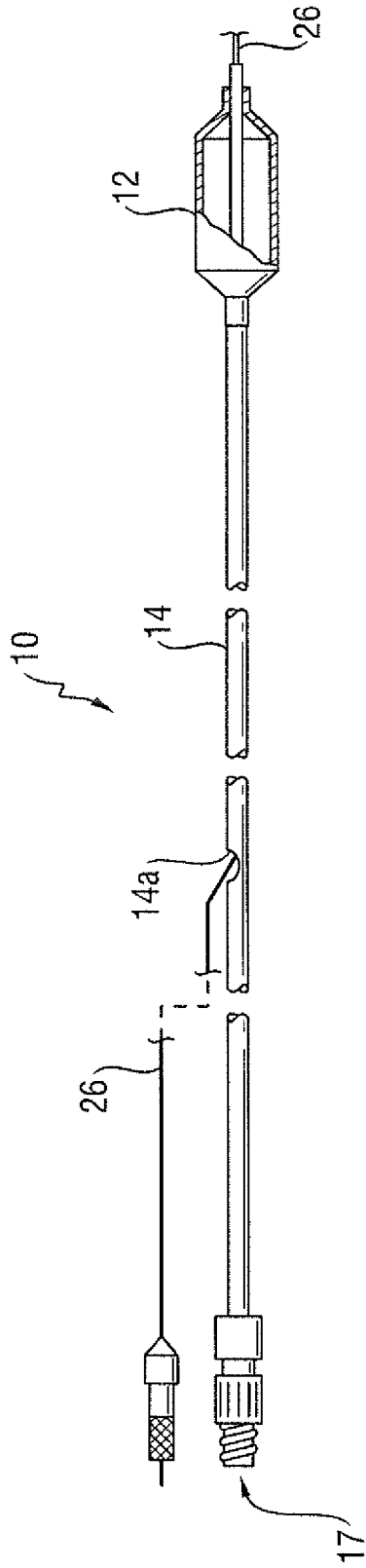


FIG. 4

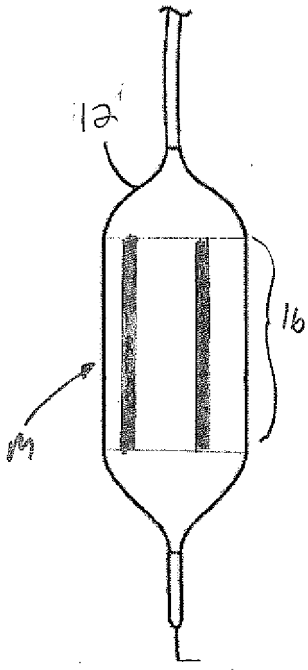


FIG. 5A

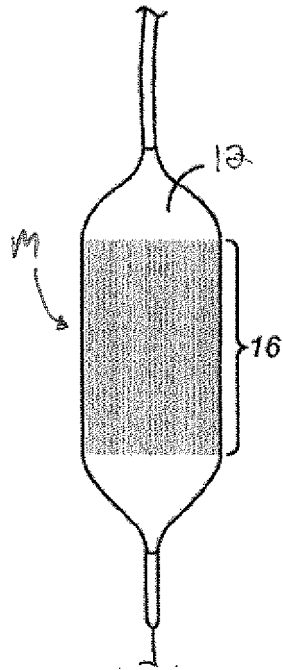


FIG. 5B

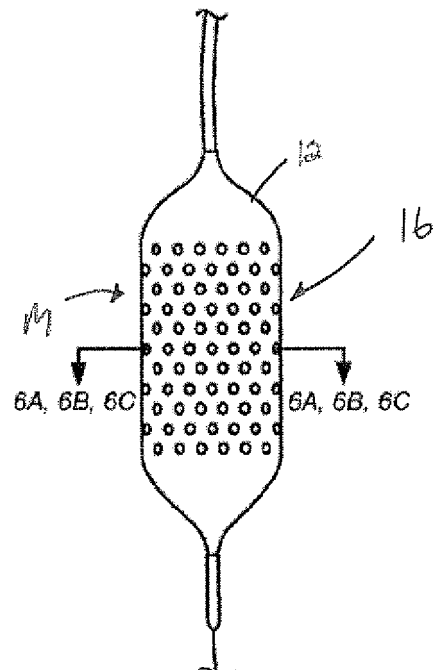


FIG. 5C

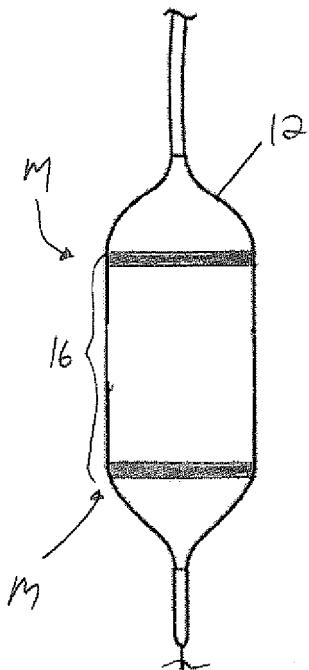


FIG. 5D

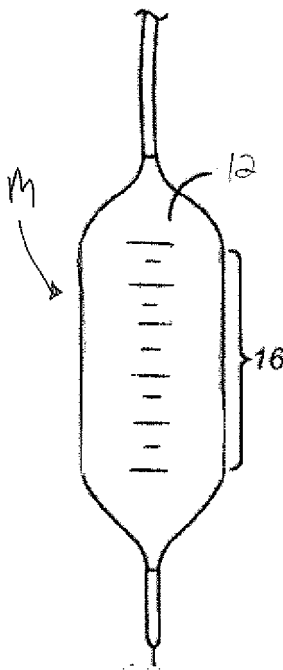


FIG. 5E

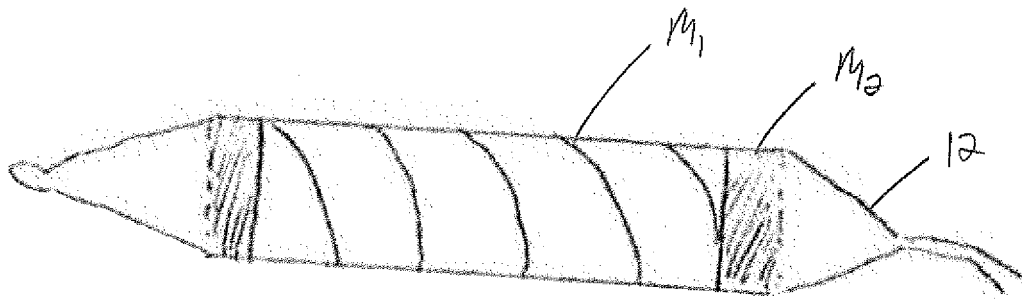


FIG. 5F



FIG. 5G

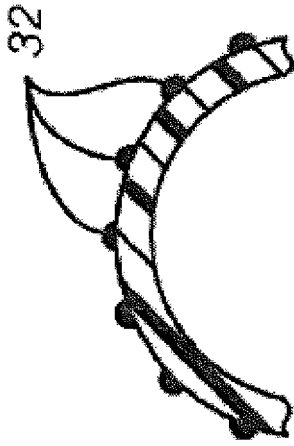


FIG. 6B

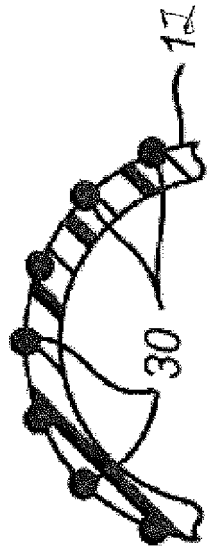


FIG. 6A

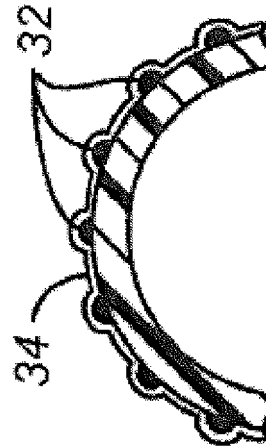


FIG. 6C

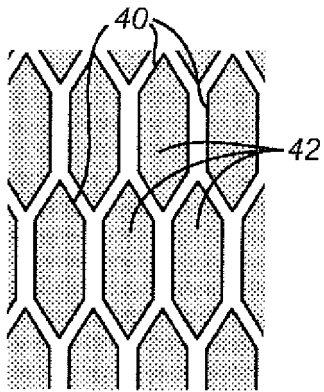


FIG. 7A

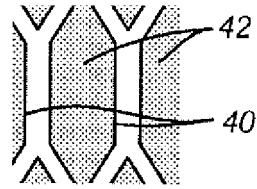


FIG. 7B

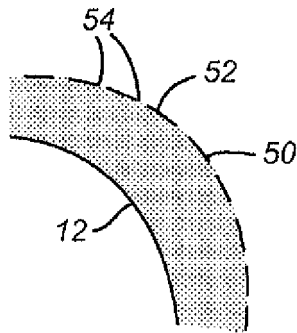


FIG. 8A

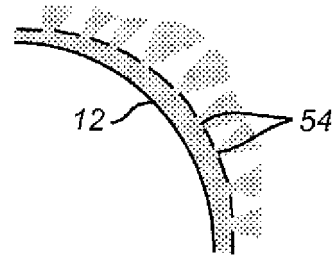


FIG. 8B

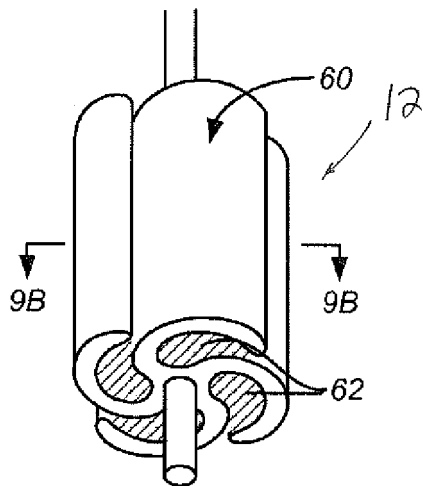


FIG. 9A

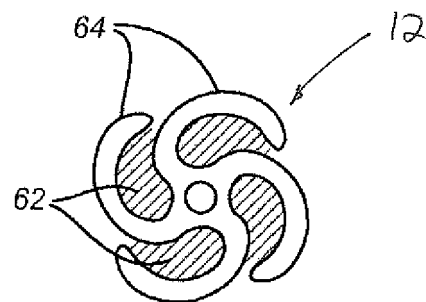


FIG. 9B

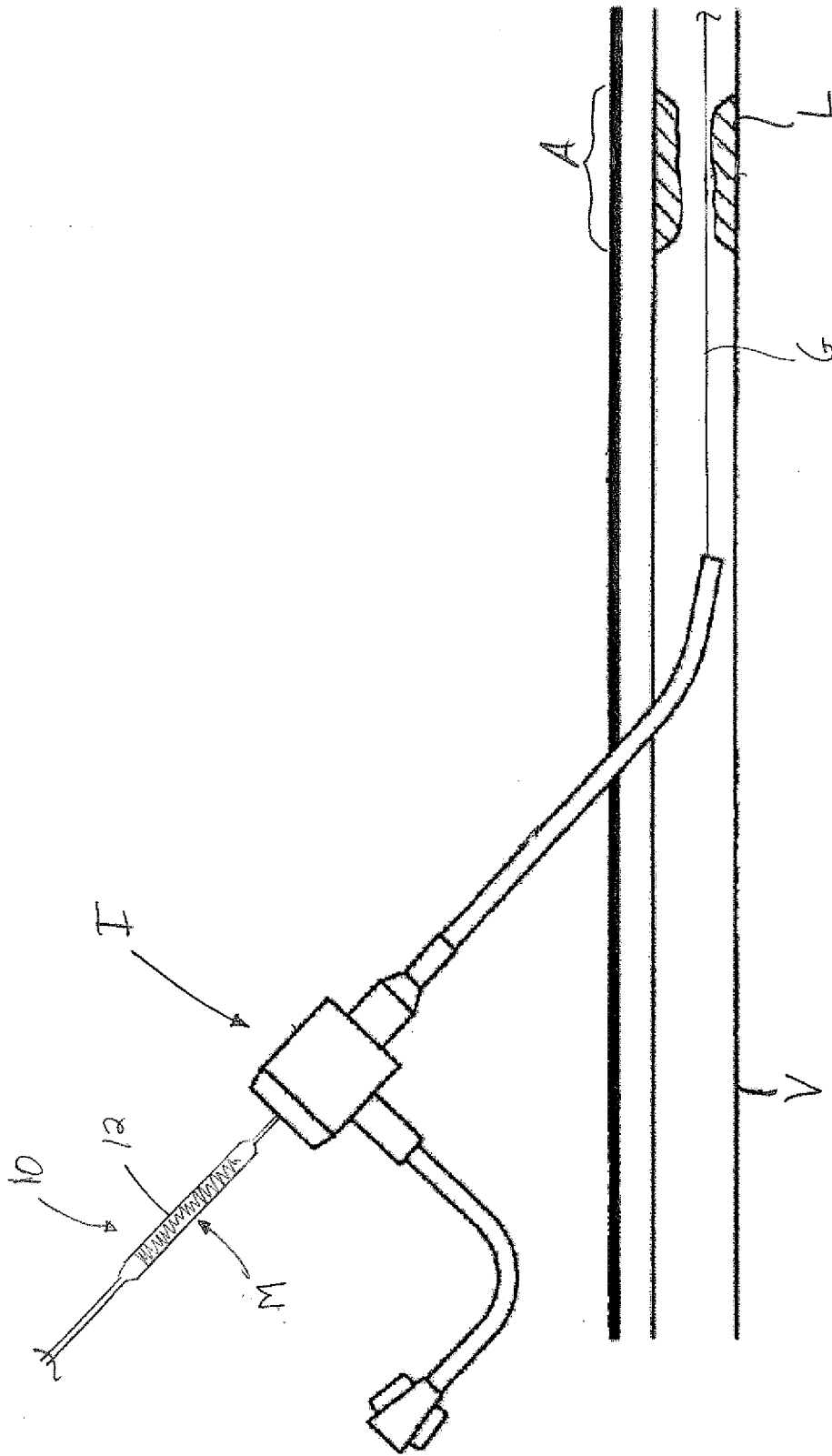


FIG. 10

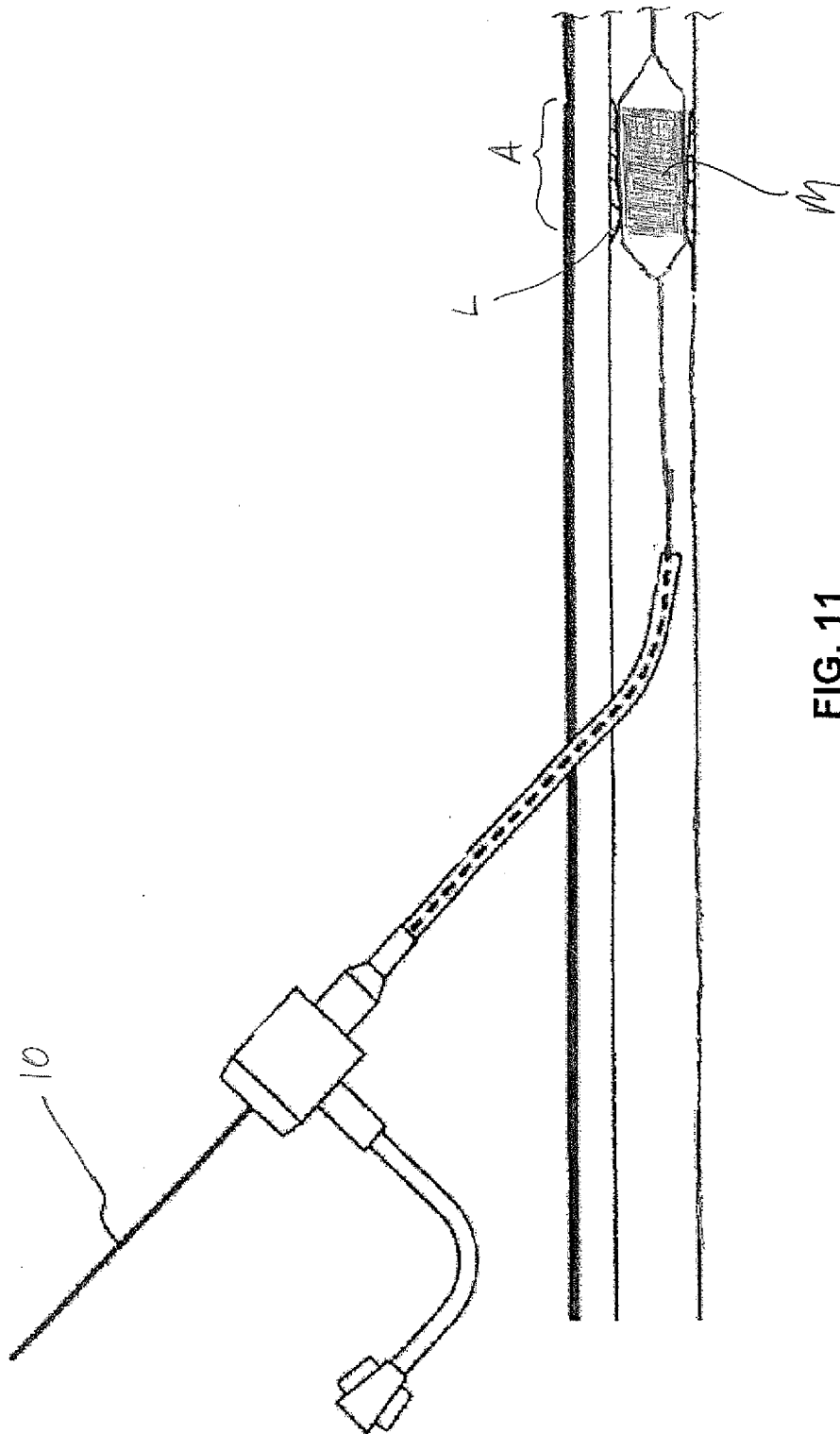


FIG. 11

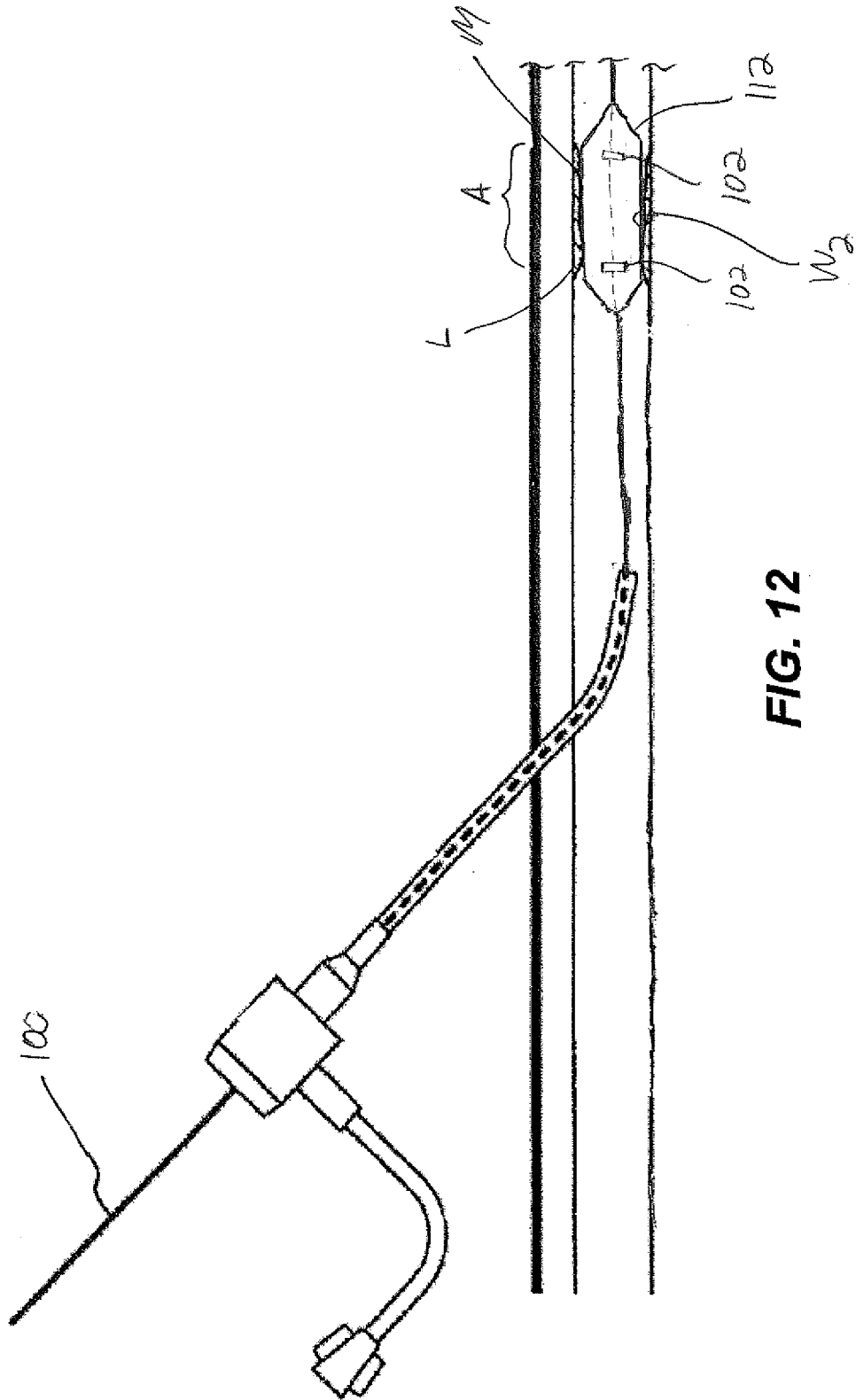


FIG. 12

REFERENCES CITED IN THE DESCRIPTION

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